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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/588,833	09/02/2008	Charles M. Lieber	H0498.70217US02	4453

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Harvard University & Medical School
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EXAMINER	
WOLVERTON, DAREN A	

ART UNIT	PAPER NUMBER
2813	

MAIL DATE	DELIVERY MODE
05/27/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/588,833	LIEBER ET AL.	
	Examiner	Art Unit	
	DAREN WOLVERTON	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 April 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *126-134 and 137-146* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *126-134 and 137-146* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *09 August 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *04/20/2010*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 126, 127, 130, 132, 133, 137, 140, 142 are rejected under 35 U.S.C. 102(b) as being anticipated by Cui et al. ("High Performance Silicon Nanowire...") (Cui hereinafter).

Regarding claim 126, Cui discloses a method comprising: providing a free-standing semiconductor nanoscale wire (page 150, lines 19-23); patterning a mask on the nanoscale wire to define at least a first portion (the ends where the electrical contacts are to be formed) not covered by the mask and a second portion (the middle portion where no electrical contacts are to be formed) covered by the mask (page 150, lines 23-27, note that the one of ordinary skill in the art would understand E-beam lithography to include: forming a resist layer, exposing the resist layer to an electron beam to create a pattern, and removing either the patterned or unpatterned areas of the resist layer to create a mask); exposing the first portion but not the second portion to a bulk metal (namely Ti, see page 150, line 26); and diffusing at least a portion of the bulk metal into the first portion of the nanoscale wire (page 150, line 27-29, note that the anneal will cause at least a portion of the bulk metal to diffuse into the silicon).

Regarding claim 127, Cui further discloses, on page 150, line 19, that the semiconductor nanoscale wire comprises silicon.

Regarding claim 130, note that Ti is a transition metal.

Regarding claim 132, Cui further discloses, on page 150, line 20, that the nanoscale wire has a smallest dimension less than 200 nm (specifically from 10-20 nm).

Regarding claim 133, Cui further discloses, on page 150, line 20, that the nanoscale wire is a single crystal.

Regarding claim 137, note that the nanoscale wire is a nanowire (specifically a SiNW).

Regarding claim 140, Cui discloses a method comprising: diffusing at least a portion of a bulk metal (page 150, line 27-29, note that the anneal will cause at least a portion of the bulk metal to diffuse into the silicon) into at least a portion of a semiconductor nanoscale wire (page 150, lines 19-23) having an approximately circular cross-section (page 150, lines 19-23, note that the nanocluster-mediated growth method will create a circular cross-section), the bulk metal and the semiconductor nanoscale wire being adjacent (page 150, lines 5-9), wherein the semiconductor nanoscale wire comprises at least one portion having a smallest dimension of less than about 500 nm (specifically from 10-20 nm, page 150, line 20).

Regarding claim 142, Cui further discloses, on page 150, line 19, that the semiconductor nanoscale wire comprises silicon.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 128, 139, 143, and 144 rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Cui.

Regarding claim 128, 139, 143, 144, Cui discloses all of the limitations of claims 127 and 140 (see the 102 rejection section above), and discloses, on page 150, lines 31-37 that silicide contacts can be formed, though it is unclear if the device described by Cui actually has silicide contacts (the minimum formation temperature of titanium silicide being around 600°C). However, even if the device disclosed does not have silicide contacts, it would have been obvious to one of ordinary skill in the art at the time of the invention to form the contacts from a silicide (with a stoichiometric ratio of metal to silicon as is commonly practiced in the art, for example: $TiSi_2$) for the purposes of creating a contact with a low Schottky barrier height.

Regarding claim 139, Cui discloses all of the limitations of claims 126 but does not disclose that the first region is able to carry a current density of at least about 108 A/cm2.

However, the claim is prima facie obvious as increasing the maximum current density of a device allows it to handle larger currents without being destroyed, and it has been held that discovering an optimum value of a result effective variable (such as the

maximum current density) involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Claims 129, 131, 138, 141, and 145 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cui as applied to claims 126, 128, 140, and 144 above, and further in view of Deng et al. ("Silicidation process using NiSi and its device application") (Deng hereinafter).

Regarding claims 129, 131, 141, and 145, Cui discloses all of the limitations of claims 126, 128, 140, and 144 as described above but differs from the claimed invention in that Cui discloses the use of Ti and Au (and thus forms Ti silicide) instead of Ni.

Deng discloses the use of NiSi as an alternative to Ti silicide.

Therefore, in view of Deng, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the invention of Cui by forming a bulk nickel layer instead of Ti and creating NiSi instead of Ti silicide.

One of ordinary skill in the art at the time of the invention would be motivated to do this in order to create a lower resistance silicide on the narrow silicide structures (see the introduction of Deng). Additionally, the claim is obvious as the substitution of one known element (Ti) for another (Ni) would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

Regarding claim 138, Deng further discloses, in FIG. 1, that the resistivity of nickel silicide is less than 60 microOhm cm and therefore it is inherent that the nickel

silicide in the combined invention of Cui and Deng has a resistivity of less than 60 microOhm cm.

Claim 134 and 146 rejected under 35 U.S.C. 103(a) as being unpatentable over Cui.

Regarding claim 134 and 146, Cui discloses all of the limitations of claim 126 but differs from the claimed invention in that the mask (for E-beam photolithography) is not disclosed as photoresist.

However, as it is common in the art to use a photoresist (particularly PMMA, though a wide variety of commercial photoresists are available), it would have been obvious to one of ordinary skill in the art at the time of the invention to use a photoresist to form the mask created during the E-beam lithography.

One of ordinary skill in the art at the time of the invention would be motivated to do this in order to use a resist that will allow high resolution patterning during the E-beam lithography.

Allowable Subject Matter

The indicated allowability of claims 134 and 146 are withdrawn in view of the newly discovered reference(s) to Cui. Rejections based on the newly cited reference(s) are detailed above.

Response to Arguments

Applicant's arguments, filed 04/20/2010, with respect to the objection to claim 143 have been fully considered and are persuasive. The objection to claim 143 has been withdrawn.

Applicant's arguments with respect to claims 126-133 and 137-146 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DAREN WOLVERTON whose telephone number is (571) 270-5784. The examiner can normally be reached on Monday to Thursday from 9:30 a.m. to 3:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Landau can be reached on (571) 272-1731. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/D. W./
Examiner, Art Unit 2813

/Matthew C. Landau/
Supervisory Patent Examiner, Art Unit 2813

DW